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Abstract: In this article, I offer what I term ‘embodied multi-material layering’ approach to study the phenomenon of laboratory or in vitro meat using insights from Don Ihde’s conception of postphenomenology and Andrew Feenberg’s theory of critical constructivism which, together, offers a reflective, analytic, and normative model of technological analysis and critique that is indispensable to the study of the cutting edge technologies that combine bioinformatics with agrifood research and biomedical engineering.

Keywords: Postphenomenology; critical constructivism, in vitro meat, laboratory meat, Andrew Feenberg, Don Ihde

In this article, I offer what I term ‘embodied multi-material layering’ approach to study the phenomenon of laboratory or in vitro meat using insights from Don Ihde’s conception of postphenomenology and Andrew Feenberg’s theory of critical constructivism which, together, offers a reflective, analytic, and normative model of technological analysis and critique that is indispensable to the study of the cutting edge technologies that combine bioinformatics with agrifood research and biomedical engineering.

The study of laboratory or in vitro meat, I use both terms interchangeably, has been taken up by critical animal studies (Tasmin and McGregor 2015), food science and technology (McHugh 2010), STS (Jönsson 2016), critical studies of the environment (Vinnari and Tapio 2009), ethics (Markus and Tapio 2017), and food culture (Buscemi 2017). It has not, however, been subject to a sustained investigation through the lens of postphenomenology and/or critical constructivism. Not only does this article analyse in vitro meat through these two grounded philosophical frameworks, but it does so in way that combines them into a novel model of analysis that I have termed ‘embodied multi-material layering.’ This approach integrates Don Ihde’s postphenomenological theory of human-technology relations, using his ‘Phenomenology of Technics’ framework, with the Andrew Feenberg’s critical constructivism which centres its analysis on the capacity for democratic interventions to reconfigure the our technological system in ways that are potentially emancipatory (Feenberg 2010, 2017). Design is thus of particular importance to Feenberg as is his central insight that the systems of lifeworld/meaning/technics/culture and instrumentality are not independent spheres but are co-constituted. Specifically, it the critical constructivist conception of ‘layering’ that I draw on to incorporate a ‘Critical’ dimension to Ihde’s theory of the technical.

The case of laboratory produced meat constitutes a unique case study through which to apply and test these respective frameworks – although it should be noted that both critical constructivism and postphenomenology have been typically been used to study more conspicuously information-based technical systems including robotics, the Internet, educational technologies, mobile media and gaming to name a few (Ihde et al 2015; Aagaard 2015; Roseberger 2012; Feenberg 2002; Feenberg and Friesen 2012; Grimes and Feenberg 2009).

Laboratory meat represents the practical application of a host of scientific and technical processes and practices that are referred to as 'NBIC' technologies (nanotechnology, biotechnology, information technology, and cognitive science). In vitro meat products, like other types of NBIC technologies, merge discrete technologies "synergistically in ways that greatly magnify their scope and power to alter lives and institutions, while also amplifying the complexity and unpredictability of technosocial change" (Vallor 2016, 17). Lab-grown meat, for the purposes of this article, also draws into this discussion themes related to the study of food culture that postphenomenology and critical constructivism might not ordinarily contend with including gender norms, heritage, identity assertions, class identifications, and sexuality.

In the analysis that follows, I begin by providing a basic introduction into in vitro or laboratory meat followed by two sections that outline Ihde's 'phenomenology of technics,' as part of his postphenomenology approach, and Feenberg's theory of layering and democratic intervention, both of which constitute core aspects of critical constructivism. These sections are used to introduce the conceptual and methodological contributions of both frameworks that are subsequently drawn on to unpack and assess the case study of laboratory meat. In the final section, I integrate the insights acquired from the preceding sections and add supplementary analysis to produce the model of 'embodied multi-material layering,' which integrates central insights from both.

In vitro or laboratory meat

In this section, I provide an introduction into laboratory meat inclusive of a basic definition, an explanation of the techno-scientific process itself, and a brief discussion of the potential benefits of these meat 'substitutes.' Providing this background aims to contextualize this particular application of biotechnological techniques such that it can then be taken up by and examined through the lens of postphenomenology and critical constructivism.

In vitro or laboratory meat can be defined simply as the production of meat without the use of animals. In terms of the process itself, it usually involves extracting stem cells from the animal and applying tissue-engineering techniques in a "suitable medium that contains nutrients, energy sources, growth factors, etc., required for the growth and differentiation of the stem cells into mature muscle cells within a bioreactor" (Bhant, Kumar and Fayaz 2015, 241). After these stem cells multiply and differentiate into muscle fibre, they can be then harvested, assembled, mixed with other ingredients, and shaped into forms that replicate, for example, beef and chicken burgers, minced meat etc.

The first concrete research into cultured meat that produced actual trials occurred under the auspices of NASA in 2002 while in Europe studies were conducted in 2006 at Eindhoven and Maastricht Universities (Goodwin and Shoulders 2013). The private sector, NGOs, charities, governments, and anonymous donors have also been active in laboratory meat research including Smithfield Foods, PETA (People for the Ethical

Treatment of Animals, and the Dutch government (Ketzel 2008; Edelman, McFarland, Mironov, and Matheny 2013). The first hamburger tasting press conference occurred amidst great fanfare in 2013.

The popularity of and support for laboratory meat within both popular discourse and scientific spaces reflects concerns around animal rights, climate change, disease, health, antibiotic resistance, and safety. Next, I turn to a brief explication of both postphenomenology and critical constructivism drawing on the case study of laboratory meat before combining insights from both into the ‘embodied multi-material layering’ approach. I then draw some conclusions related to this approach as well as the potential of laboratory meat going forward.

Postphenomenology

As described by other contributions to this special issue, the practice of postphenomenology aims to pragmatically ground phenomenological analysis by subjecting it to a so-called ‘empirical turn’ (Ihde 2009; Ihde et al, 2015; Rosenberger and Verbeek 2015). Thought of in this way, postphenomenology can be conceptualized as a theory that abandons transcendentalism in favour of pragmatic, situated and embodied analysis that, methodologically, embraces an empirical position which centres “an appreciation of multidimensionality of technologies as *material cultures* within a *lifeworld*” (Ihde 2009, 22). Technologies like laboratory meat, as such, are not simply objects that contain certain qualities and capacities, rather, they are woven into our experience in ways that, through direct engagement, reveal “structural features of those ambiguous [human-technology] relations” (Zwier, Block and Lemmens 2016).

One of the central insights of postphenomenology, posed in the form a foundational question and applied to the particular technology at hand, asks: how does this technology shape human subjectivity and the world as a meaningful object? It is this aspect of postphenomenology that I draw on to examine laboratory meat and which I then use to provide the scaffolding for my ‘embodied multi-material layering’ framework. Specifically, it is Ihde’s ‘phenomenology of technics’ approach I draw on in which he argues that there are four formalistic structures of human-technology relations that we can use to understand the human-technology relationship – namely, the embodiment relation, the hermeneutic relation, the alterity relation, and the background relation (Ihde 1990, 2012). I employ these frames as analytic tools to unpack the types of new associations, experiences, cultural mores, anxieties, fears, and intra and inter active linkages that might form with the introduction of laboratory meat. Again, because the majority of applications of postphenomenology tend to take up informatics, some of these frames fit more easily than others to the unique case of in-vitro meat but which, I contend, are revealing nonetheless.

Embodiment relation

The embodiment relation, according to Ihde, facilitates the ability for the technology at hand to represent the external world in a manner that reshapes our, i.e. the user’s,

experience. In doing so, it “draws attention to how technologies can merge with our body and thereby alter our relation to the world” (Ihde 1990, 90). This relation is reminiscent of Marshal McLuhan’s conception of technology and extensions of the human body which is best exemplified by electric technologies which, according to McLuhan,

...[extend] our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned. Rapidly, we approach the final phase of the extensions of man - the technological simulation of consciousness, when the creative process will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media (McLuhan 1966, 19).

On a more local scale, we can think about wearable computing technologies, robotic arms, implanted chips and other devices which are all technologies that reflect an embodiment relation in which traditional bodily capabilities are extended and amplified through a process of body-technology assimilation.

On the level of embodiment, and applied to the case study at hand, it is useful to contrast the human-technology relation between consumers and farm-based meat products to that of the relations fostered by in-vitro meat. While there are multiple ways to examine this, one that comes to mind is the relationship between masculinity and meat which is rooted in meat’s historical association with power, control, and domination that is reflected in high levels of consumption (Sobal 2005; Sumpter 2015). Carol Adams, in her seminal text, *The Sexual Politics of Meat*, conducts a historical and analytic study in which she unpacks power/meat nexus through the lens of violence, the denigration of women, and absolute power.

Adams demonstrate the rise of meat eating as a dominate mythology wherein “meat is [is seen] a masculine food and meat eating activity” (Adams 2004, 249), such that meat comes to be thought of as “the essence or essential part of something” (Adams 2000, 46). Conversely, the consumption of vegetables and other non-meat products are associated with femininity. This meat/vegetable//carnivore/vegetarian binary works to perpetuate constructed gender norms in which meat eating is believed to reflect “rationality, authoritarianism and hierarchy, while vegetarians and vegans [read women] [reflect] emotions, social justice and peace” (Buscemi 2017, 21). In a context in which meat and meat eating comes to represent closely held cultural and historical affinities between the male hunter/farmer’s domination of nature, the consumption of meat as an act of metaphysical and trans-substantial transference of nature’s power to the person who consumes it, it is uncertain how laboratory meat might transform this socially significant embodiment relation.

On the one hand, it might be conceivable that there would be a significant amount of resistance to laboratory meat based on the meat-masculinity nexus which Phillips and Wilks point out in their 2017 comprehensive survey of American public attitudes to in vitro meat (although they also note that taste and price are also important factors to

overall resistance) (Wilks and Philips 2017). On the other, it is might also be the case that laboratory meat could sever the often toxic connection between meat and masculinity in ways that are progressive, pro-social, and, as such, foster more equitable gender relations. Either way, it is important, in the context of the embodiment relation, to consider how new technologies like laboratory meat function on the visceral level of embodiment and subjectivity in light of meat's unique capacity to literally become part of the body.

Hermeneutic relations

The hermeneutic relation, for Ihde, is characterized by the ways in which our experience with the technology at hand is interpretively transformative, both in terms of our relation to the technology itself and with respect to our relation with the world, through our experience with it. Common examples include a watch or microscope, which are significant "not [only] as mere 'instrument' but as a way [*sic*] of seeing (and manipulating) the world" (Coeckelbergh 2010, 198). Thus, if we think of the technology at hand like a text, i.e. interpretively, we can come to understand how its meaning emerges in a "perceptual gestalt" with its user for whom knowledge of how to 'read' and make meaning out of the technology is key (Rosenberger and Verbeek 2015, 17).

Because familiarity is important to the hermeneutic relation, in the context of in vitro meat, it is important to think about the feeling of conviviality that emerges with social practice of meat eating which, despite its very real imbrication in factory manufacturing, is connected, particularly in a North American and Western European context, with wealth, celebration (barbeques, birthdays) pleasure, holidays (Fourth of July, Thanksgiving, Christmas) etc. (Kittler, Sucher and Nelms, 2011). This, of course, extends to other cultural milieus in both similar and divergent ways. What unites them all is the reading of meat and meat eating as cultural significant in ways that are rooted in assumptions about how they are produced and sourced either implicitly or explicitly (da Silva Gomes Ribeiro and Corção 2013; Devi, Balachandar and Lee 2014; Seleshe and Lee 2014).

Based on the common assumption that the meat we traditionally consume comes from a sourceable living, breathing animal, is important to consider the levels of cultural rupture or discord that is likely to arise with the realization that the food now being consumed has been cultivated in a sterile lab. McHugh describes this uneasiness best with his characterization of fake meat as bringing with it "a global sense of gone-wrong-edness [*sic*] in environmental relations across species as characteristic of modern living" (McHugh 2010, 182).

This also speaks to a difficulty of moving into a readerly relation with a new technology like laboratory meat which fits uneasily with the mythopoetic significant placed on how it has been believed to conventionally be produced as part and parcel of traditional Americana. Anthropologically, myths of this sort, tell us "something about the origins of peoples," providing "people a feeling of belonging or participating in a common dream" by "elucidate[ing] values," (Grigsby 1980, 95). The mythos associated with the production of meat, particularly in the US but also in Europe, is tied up with closely held

notions of the frontier, rugged individualism, the ‘Wild West,’ and utopic agrarianism that may be difficult to give up” (Slotkin, 1998) and which, in the context of the hermeneutic relation, produces a material and ideological interpretation of reality for its users or, in this context, its consumers.

Alterity Relation

The alterity relation, for Ihde, centres on the ways in which we take up technologies which tend to mirror our relations with other people – which is to say in a relation of Otherness. Ihde refers to this as a relation of quasi-otherness: “Technological otherness is a *quasi-otherness*, stronger than mere objectness but weaker than the otherness found within the animal kingdom or the human one...” (Ihde 1990, 100; Hasse and Tafdrup 2017).

While this may be easy to conceive of with respect to, say, human-robot relations or a computer interface in which they take on the role of the quasi-other, that is, a role similar to that of other people with whom we would traditionally engage with, it is more difficult to apply in case of laboratory meat. However, there are three ways in which the alterity relation can be conceived in ways that illuminate in vitro meat’s relation and effects on one’s lifeworld and social relations. First, is the alterity relation laboratory meat has with its natural counterpart, which is manifest in the fact that it is currently being produced to look, feel, taste, and generally mimic the meat products everyone is used to. This second degree mirroring is significant in that it points to how important, particularly with respect to something as socially meaningful as food, that its Otherness is mitigated as much as possible.

Second, it is also the case that in vitro meat’s alterity relation might not necessarily be manifest with the eating of the meat product itself, but with the technologies that are likely to be associated with its consumption. I am thinking here of its potential positioning in the current matrix or ecology of surveillance and dataveillance saturated wellness culture (Millington 2014; Lupton 2016). While laboratory meat has been lauded by some environmentalists, vegan activists, and health professionals, it has already been suggested that it could be produced in ways that are tailored to individual health needs in terms of nutritional composition (lower levels of saturated fat, added probiotics and fibre) and devoid the negative consequences of cooking at high temperatures and the side effects of added hormones and/or antibiotics. Of course, these products would be available solely to those able to afford it. Their data would be fed into digital tracking devices that would then instruct us on how to “prevent the pathologised body” while “reproduce[ing] dominant discourses about the ‘fit’ and healthy body” (Fotopoulou and O’Riordan 2017, 57), and subsequently target us with the appropriate products through which to do so.

Finally, the alterity relation is also likely to play out in the context of Ihde’s characterization of the technology as an object of “appreciation and fascination which characterizes much of the experience of modern technologies” (Ihde 1995, 109). This has

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3 already played itself out some of the more euphoric media coverage of in vitro meat
4 tastings, trade shows, and new innovations (Post 2014). Erik Jönsson refers to this
5 technophilic optimism as enacting a benevolent technotopia with respect to health, the
6 environment, and animal rights (Jönsson, 2016).
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9 Background Relations
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11 Finally, Ihde’s background relation speaks to how we integrate technologies into our
12 environments in ways that render them superfluous – i.e. part of our everyday lives, such
13 that we interact with them in ways that shape our experiential surroundings (Rosenberger
14 and Verbeek 2015, 19) (e.g. like the refrigerator, heating and lighting systems etc.). What
15 is most significant about the background relation of technologies is that they work
16 without our being specifically prompted to enact them or to understand how they work,
17 but are vital in that they often act to keep us safe and our lives running smoothly. That is,
18 they play a role in human experience in ways that “are not always perceived as such but
19 still shapes how people perceive their environment” (Aydin, Woge and Verbeek 2018).
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23 The food we eat constitutes one such system that that is an ideal manifestation of the
24 background relation in that we, as consumers, rarely have a sense of where the food came
25 from, how it was produced, by whom, and under what conditions. It is an example of
26 commodity fetishism par excellence but one that might not easily transfer to in vitro meat
27 (Morris and Kirwan, 2010). In fact, over the last decade or so the ‘backgroundness’ of the
28 meat industry has frequently come to the foreground in light of animal rights concerns,
29 adulteration scandals, health scares/panics (avian influenza, mad-cow disease), nutrition-
30 based concerns, and an overall distrust of science (Abbot and Coles 2013).
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33 This foregrounding is likely to continued with laboratory meat and add to established
34 anxieties around corporate control and lack of transparency, the monopolization of
35 intellectual property rights, concerns about the loss of jobs, as well as a nationally and
36 culturally resonant industry, and an overall uneasiness about genetic manipulation and the
37 very act of creating life in lab (Marcu et al, 2015). In whatever form it gets to market,
38 how in vitro meat is advertised, labelled, and covered by the media is key since “even
39 positive intended information can fuel consumer resistance because it can increase
40 awareness of previously unknown risks” (Verbeke, Sans and Loo 2015), and thus prevent
41 the technology from being enacted as a background relation.
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45 Overall, this four-part parsing of human-technology relations articulated by Ihde provides
46 a lens through which to consider in vitro meat as a technology that is both experiential
47 and empirical. The insights gleaned from the preceding analysis of the alterity,
48 hermeneutic, embodiment and background relations of laboratory meat are significant,
49 yet, I would argue they lack a normative political theory or conceptualization of social
50 change which Andrew Feenberg’s theory of critical constructivism does.
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53 Critical Constructivism
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Andrew Feenberg's approach to technology and technological systems aims to challenge its traditional conceptualization as having predetermined, immutable, and essential characteristics. Rather, his thesis is that technologies, particularly with respect to their potential uses and effects, should be examined first through the lens of design which has the capacity to be redefined, reconceptualised, and transformed anew through considered democratic interventions into the design process itself (Feenberg 1999). As such, technologies are seen as ambivalent and simultaneously capable of conserving hierarchy or opening up to new potentialities. Democratic rationalism, according to Feenberg, sees new technologies as capable of "undermin[ing] the existing social hierarchy or to force it to meet needs it has ignored. This principle explains the technical initiatives that often accompany the structural reforms pursued by union, environmental, and other social movements" (Feenberg 1999, 76).

It is from this central insight that critical constructivism, which forms but one part of Feenberg's framework, that he introduces his important conception of 'layers' in which Feenberg, borrowing from Marx, offers a way to study the multidimensionality of technology as constituted by "layers [or assemblages] of function and meaning" (Feenberg 2013, 3) that are socially, technically, politically, and economically ambiguous, that serve a multiplicity of interests, and that have the capacity to subvert a capitalist rationality that perceives of technologies as apolitical, rational, and progressive. By unravelling or 'de-concretizing' these layers, it becomes possible to identify nodes of repression and emancipation rooted in design and, in doing so, interpret "the meaning of social objects" by "multiplying the contexts within which objects take on meaning and function" (Feenberg 2013, 8). It also opens the door to beginning to conceive of technological innovations that are participatory, pro-social, and capacity enhancing.

Again, the technologies that this framework would traditionally be applied to are digital technologies like the Internet whose layers include that of hegemonic functionality, economics, and culture (Feenberg 2013; Barney 2011). Possible layers associated with in vitro meat could be assessed using these same layers, which by no means constitutes an exhaustive list, but which challenges us to rethink how politics figures into how vitro meat functions on a number of levels.

It is important to remind ourselves, in light of this, that all technologies have complex lives and are co-constituted with and by the socio-political. Food technologies, and food in general, is unique in that it plays a determinative role in one's very ability to survive and thrive while also acting as a vital system of communication "imbued with social meaning, cultural practice, and political ideology" (Willard 2002, 105). Beardsworth and Keil put it this way: "[W]hen we eat, we are not merely consuming nutrients, we also consuming gustatory (i.e., taste-related) experiences, and, in a very real sense, we are also 'consuming' *meanings* and *symbols*" (Beardsworth and Keil 2002, 51). As such, the layers of value and meaning that comprise Feenberg's critical constructivism, when applied to food, must take both these elements into account.

Currently, the way in which in vitro meat has developed, in light of the layers of functionality, production, and cultural significance, is consistent with what Feenberg

refers to as the neoliberal consumption model of technology in which its technical code, so to speak, is ‘programmed’ to pursue profit, intellectual property rights, corporate control, and overall instrumentalization. This culture of technical instrumentalization and abstraction is one which Habermas refers to as the ‘colonization of the lifeworld’ in which the kind of instrumental rationality consistent with the administration of the government and economy “have increasingly come to pervade other areas of life and make them over in their own image and likeness” (McCarthy 1991, 52). Feenberg extends this model to the realm of contemporary technologies which, while often thought to be constituted by a neutral and objectifying ethos, incorporates and reflects social values and norms that can be hierarchical and constraining or prosocial and democratizing (Feenberg 1995, 2003). Assessing laboratory meat through these layers, unlike the preceding analysis of Ihde’s four relations, contains much more overlap. As such, the analysis that follows touches on elements of what food is for (function), how it comes to be (production), and how it impacts and constitutes core elements of our lifeworld (culture) simultaneously. A more focused (i.e. read longer) analysis would be able to parse the specific characteristics of each layer into more analytically refined categories but, for the purposes of this piece, I highlight aspects of these layers and their relevance to the possibility of democratizing technology as they emerge throughout.

A robust critique from the perspective (i.e. layers) of production, function, and culture, based on the Feenberg’s critical constructivist framework, can be seen in Zurr and Catt’s piece, “Life as Raw Material: Illusions of Control” in which they argue that in vitro meat signposts a fundamental transformation to our conception of life based on control and manipulation that *functionally* renders life as simple “biomatter, waiting to be engineered” (Catts and Zurr 2012, 252) by those with the capital and expertise to do so. Catts delivers a similar critique in an article for the online publication, *The Conversation*, in which he draws this argument into the mainstream by making the case that lab-grown meat is part of a new industrial initiative, namely cellular agriculture, that is increasingly being driven by a techno-capitalist mindset of venture capitalists in Silicon Valley who are, in fact, “prolonging the West’s excessive consumption of meat, rather than genuine[ly] attempt[ing] to deal with the problems they aim to solve” (Catts 2017).

A particularly salient insight with respect to the layer of culture that, again, adds a political critique rooted in a democratic conception of technology and which pushes up against a subsumption model of nature that sees the nonhuman as open to manipulation, can also be understood through the lens of the biopolitical in which the discourse surrounding in vitro science has been cultivated by corporate interests through the lens of speciesism which binarizes the human-animal relation and re-presents the animal world as open to the “wilful exploitation of animals for human gain, whether in terms of consumption, entertainment, or research” (Simonsen 2015). It also functionally redefines life as text in which “the [animal] body is increasingly seen not as organic substratum but as molecular software that can be read and rewritten” (Simonsen 2015). This doubles down on and extends established modes of food production consistent with the consumption model of technological development.

Another lighter, yet enlightening, exploration of the cultural layer, also rooted in a critique of the consumption model of technological development, can be offered by the study of the ‘yuck’ factor, defined by Cannavò as the feeling of repugnance that seems to arise at the thought of food produced in ways perceived of as inherently unnatural which highlights what feels morally troubling about “raising artificial meat in a tank” and reflects the fear we have of technologies moving “us further down a troubling path toward an entirely denatured machine existence” (Cannavò, 2010). This feeling speaks to a social desire to hew to the familiar, natural, and bounded and away from the abject technological Other (Gaggi 2003).

However, this ‘yuck’ factor could potentially be mitigated if, for example, a discourse of contamination is introduced in which the public’s fears around industrialized agriculture and increasing cultural demand for purity and embrace an ethos of ‘cleanliness’ with respect to food (i.e. clean eating), is coupled with in vitro meat’s environmental benefits and animal cruelty free ethos which might displace this feeling while remaining in the confines of the consumption model (Murray 2018).

These insights are also reflective of the layers of production and function since it highlights the existential importance of the process by which technologies are produced and who controls the key aspects of decision making. This is particularly salient with respect to food which, on a functional level, is what sustains us and provides us with a sense of physical wellbeing and which, when compromised, can have devastating consequences. It is important to point out the very undemocratic control of in vitro meat with handful of corporate interests (Memphis Meats – an American startup with funding from Bill Gates and Richard Branson, Hampton Creek, Mosa Meat, Aleph Farms, and Finless Foods) leading research and development and holding the majority of key patents (Smetana 2017; Carrington 2018).

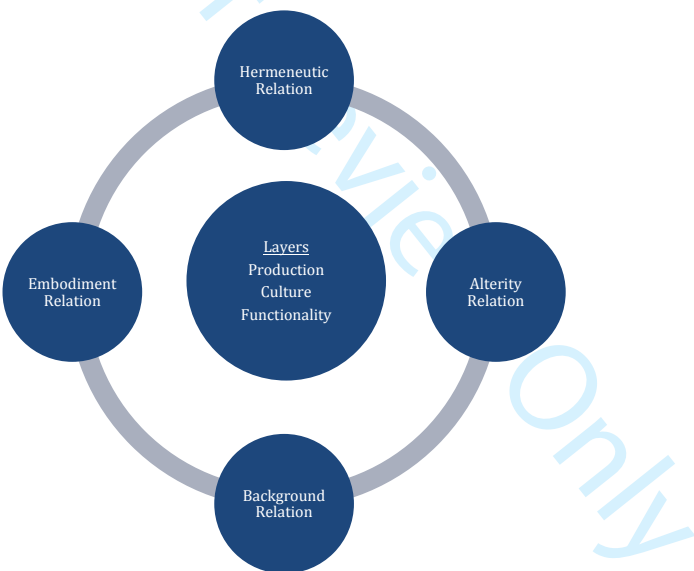
However, this is not *the* determinative model of technological develop, design, or use since technologies themselves, according to Feenberg, are part of “the self-conscious construction of technological worlds supporting a desirable conception of what it is to be human” (Feenberg 2003, 214-15). A *community model* of technological development, in contrast to the consumption model, would parse and express the layers that constitute its code much differently, i.e., through the lens of democratic participation and control, human agency, and democratic processes (Bakardjieva and Feenberg 2002).

In the context of laboratory meat, this would entail and call for an opening up of experimentation, protocols, planning, and even intellectual property to public scrutiny and input. A community-based model of technological development would also require the demystifying of technologies with respect to decision-making as well as design. Feenberg, in his examination of the French Minitel, specific aspects of Internet culture, and the democratization of medical research, ultimately comes to the conclusion that the structures of power and authority of our current social world, while technocratically leaning, are contestable (Feenberg 1991).

It is clear, however, that these demands pose a tall order given the current political economy of in vitro meat wherein research and development, and the capital required to engage in both, is held in a small number of hands. A salient example of how this might work can be done, however, can be seen in the Shojinmeat Project which is a Japan-based *open-source* “hobbyist club” aimed at providing protocols and equipment for regular people to experiment with ‘clean meat’ in the spirit of citizen science initiatives of the past (<https://shojinmeat.com/wordpress/en/>). Unfortunately, however, this appears to be the only initiative of this sort currently operating.

Conclusion

Taken together, I propose a multiscalar model of ‘embodied multi-material layering,’ as exemplified by the image below as a means by which to draw together the most insightful elements of postphenomenology and critical constructivism into one productive platform.



Having a model that combines the insights of technological democratization and an empiricized phenomenology reflects a robust way through which to better analytically understand the interplay between “human-technology-world” relations and how these relations form and reform with respect to new technologies. It also makes space for assertions of human agency, social movements, and acts of subversive engagement to democratize technologies in ways that reflect participant interests in line with an alternative, de-essentialized and non-technocratic modernity as exemplified by my analysis of in vitro meat (Rosenberger and Verbeek, 2015; Feenberg 1991).

In summary, when applied to the study of in vitro meat, the ‘phenomenology of technics’ model put forth by Ihde reveals the following:

To begin with, the examination of in vitro meat through the embodiment relation unearths the relation of meat itself to the ideology of control, power, violence, and hegemonic gender norms while the analysis through hermeneutic relations speaks to the themes of culture, meaning and myth making, and belonging not likely to be given up easily by a culture in which meat reflects both frontier history and celebration. The alterity relations revealed by a postphenomenological study of laboratory meat speaks to the likely clash between familiarity and Otherness that is apt to become thematized by its consumption, as well as by sparking conversations around wellness culture, hyperconsumerism, and environmental consciousness.

Finally, Ihde's background relation exposes the potential difficulties laboratory meat will face before becoming a 'background' technology formally ensconced in the mundane milieu of our shared lifeworlds. This is particularly the case in light of fears we have around food and naturalness, adulteration, industrial production, and corporate control. What Feenberg's critical constructivism adds to the preceding analysis is a possible corrective (as in normative) vision of modernity in which technological development and design moves into the hands of the public and from a neoliberal consumption model of growth to a community-based model characterized by radical democratization.

Cumulatively, the insights gleaned from an analysis of technological artifacts using Ihde's postphenomenological quadripartite model of world relations and Feenberg's theory of critical constructivism offers a framework through which to study the undertheorized aspects and potentialities of new technologies like that of in vitro meat in ways that combine normative politics and democratic theory with a naturalized conception of embodied technological relations into a framework I have termed 'embodied multi-material layering.' In vitro meat offers a particularly illuminating case study in that it speaks to and integrates a variety of technological, socio-cultural, and political anxieties and concerns including basic sustenance, meaning-making, cultural mythologies, pleasure, environmental consciousness (inclusive of animal rights), trust in science, public policy, profit-seeking, regulation, decision-making, biological manipulation, human health, and the status of life. Overall, I anticipate that the application this novel framework to other life science-based technologies will result in novel analysis and insights that are not be readily accessible using existing models. I look forward to engaging in and learning about such applications going forward.

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